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INVENTOR-INFORMATION:

NAME	COUNTRY
IMANAGA, AKIYOSHI	
HANEDA, MITSUAKI	
FURUSAWA, KOICHIRO	
SHIBATA, NOBUO	
NAKAJIMA, YOSHIO	
KIKUCHI, HIRONARI	
UEHARA, TAKEO	
KOBAYASHI, MASAHIRO	
HINO, EIJI	
MIZUGUCHI, KAZUHIKO	

ASSIGNEE-INFORMATION:

NAME	COUNTRY
HITACHI LTD	N/A

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ABSTRACT:

PURPOSE: To achieve the full automation of the welding work in a groove joint welding of a work to be welded with a groove block on the weld line using a detecting means capable of detecting the position of an obstacle when no welding is achieved and detecting the information on the groove during the welding, and realizing the automatic welding jumping the obstacle and the automatic welding after the obstacle is removed.

CONSTITUTION: After the position, etc., of a groove block 3 installed on a groove joint 2 before the welding is detected by a sensor head 21 and a sensor image processor 22, a mobile welding control head 9 is traveled based on the detected results to start the automatic welding, a welding torch 6 is jumped at the part with the groove block 3, while the temporary welding is achieved at the part without any groove block 3, and the divided welding is achieved. After the groove block 3 is removed, the connection welding, the initial pass back bead welding, the multi-layer multi-pass welding in the whole region in the groove joint are automatically achieved while the welding position of the welding torch 6 is successively monitored by the sensor head 21.

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[Claim(s)]
[Claim 1]A welding torch of working which welds to a groove joint characterized by comprising the following formed in a comparison part of a welding work, A welding control head of a self-propelled formula is provided with a torch driving means which drives this welding torch, meets a weld line of said groove joint mostly, and it runs to a direction of movement of welding, A guide rail to which it shows a run of said welding control head, and the 1st detection means that detects a welding position of said welding torch at the time of welding, Automatic welding equipment which has a control means which controls welding output conditions of said welding torch, drive operation of said torch driving means, and run operation of said welding control head based on a detection result of this 1st detection means, and performs welding to said groove joint.

Have further the 2nd detection means that detects the position, shape, and a size of an obstacle formed groove shape of said groove joint, and in this groove shape at the time of un-welding, and, [and said control means] So that said welding torch may weld a portion which does not have said obstacle among said groove shape based on a detection result of the said 1st and 2nd detection means, and a portion which has said obstacle among said groove shape may not weld but this obstacle may be jumped over and avoided, A jump welding control means to control welding output conditions of said welding torch, drive operation of said torch driving means, and run operation of said welding control head.

A continuous-welding control means by which said welding torch controls welding output conditions of said welding torch, drive operation of said torch driving means, and run operation of said welding control head based on a detection result of said 1st detection means to weld continuously over the whole region within said groove shape.

[Claim 2]The automatic welding equipment comprising according to claim 1:
A line floodlight with which the said 1st and 2nd detection means are the one same detection means, and this one detection means irradiates said groove joint with linear light.
A camera which picturizes a reflected figure of said linear light.
An image processing means which carries out Image Processing Division of the detection image of this camera, and extracts required information about said groove shape, the position, shape and a size of said obstacle, and said welding position.

[Claim 3]The automatic welding equipment comprising according to claim 1:

The 1st course calculating means that calculates a welding path in case, as for said continuous-welding control means, said welding torch welds inside of said groove shape over the whole region.

The 1st welding execution means that controls welding output conditions of said welding torch, drive operation of said torch driving means, and run operation of said welding control head, and performs continuous welding covering the whole region within said groove shape based on the result of an operation of this 1st course calculating means.

[Claim 4]In the automatic welding equipment according to claim 3, [said continuous-welding control means] Welding output conditions of said welding torch have further the 1st welding condition memory measure that a setting input is beforehand carried out as two or more kinds of welding data, and is memorized, and, [said 1st welding execution means] Automatic welding equipment performing continuous welding covering the whole region within said groove shape according to one of two or more kinds of welding output conditions memorized by said 1st welding condition memory measure.

[Claim 5]In the automatic welding equipment according to claim 4, among two or more kinds of welding data memorized by said 1st welding condition memory measure, [at least a part] Automatic welding equipment being data of tack-welding conditions which are the energy of a size which melts only a side front of said groove joint and does not melt the back side.

[Claim 6]In the automatic welding equipment according to claim 3, [said continuous-welding control means] A deviation of a running direction of said welding control head at the time of welding and the direction of a weld line of said groove joint is calculated by being based on a detection result of said 1st detection means, Have further the 1st compensation means that amends a welding path calculated by said 1st course calculating means according to this deviation, and, [said 1st welding execution means] Automatic welding equipment controlling welding output conditions of said welding torch, drive operation of said torch driving means, and run operation of said welding control head based on this amended welding path.

[Claim 7]In the automatic welding equipment according to claim 6, said 1st detection means is the position preceded in the welding direction rather than said welding torch, and it is being fixed to said welding control head so that it may become a position higher than height of said obstacle.

Said 1st compensation means taking into consideration delay distance of said welding torch which is late for said 1st detection means, and runs based on a deviation calculated based on said 1st detection result. [the compensation means] Automatic welding equipment performing delay **** amendment which amends a welding path calculated by said 1st course calculating means.

[Claim 8]In the automatic welding equipment according to claim 1, [said jump welding control means] The 2nd course calculating means that calculates an evasion course for a welding path and this welding torch in case said welding torch welds a portion which does not have said obstacle among said groove shape to jump over and avoid said obstacle, Automatic welding equipment having the 2nd welding execution means that controls welding output conditions of said welding torch, drive operation of said torch driving means, and run operation of said welding control head, and performs jump welding based on the result of an operation of this 2nd course calculating means.

[Claim 9]In the automatic welding equipment according to claim 8, said jump welding control means has further the 2nd welding condition memory measure the setting input of the welding output conditions of said welding torch is beforehand carried out as two or more kinds of welding data, and they are remembered to be.

Automatic welding equipment, wherein said 2nd welding execution means performs welding in said welding path according to one of two or more kinds of welding output conditions memorized by said 2nd welding condition memory measure.

[Claim 10]In the automatic welding equipment according to claim 9, among two or more kinds of welding data memorized by said 2nd welding condition memory measure, [at least a part] Automatic welding equipment being data of tack-welding conditions which are the energy of a size which melts only a side front of said groove joint and does not melt the back side.

[Claim 11]In the automatic welding equipment according to claim 8, [said jump welding control means] A deviation of a running direction of said welding control head at the time of welding and the direction of a weld line of said groove joint is calculated by being based on a detection result of said 1st detection means, Have further the 2nd compensation means that amends a welding path calculated by said 2nd course calculating means according to this deviation, and, [said 2nd welding execution means] Automatic welding equipment controlling welding output conditions of said welding torch, drive operation of said torch driving means, and run operation of said welding control head based on this amended welding path.

[Claim 12]In the automatic welding equipment according to claim 11, [said 1st detection means] Are the position preceded in the welding direction rather than said welding torch, and it is being fixed to said welding control head, and so that it may become a position higher than height of said obstacle, [said 2nd compensation means] Automatic welding equipment performing delay **** amendment which amends a welding path calculated by said 2nd course calculating means taking into consideration delay distance of said welding torch which is late for said 1st detection means, and runs based on a deviation calculated based on said 1st detection result.

[Claim 13]Automatic welding equipment welding in the automatic welding equipment according to claim 1 to a rectilinear shape groove joint of a welding work of approximately flat plate shape.

[Claim 14]Automatic welding equipment performing all position welding to a circumference shape groove joint of an approximate circle pipe-shaped welding work in the automatic welding equipment according to claim 1.

[Claim 15]The 1st automatic detection means detects a welding position of a welding torch of working with which a welding control head of a self-propelled formula was equipped characterized by comprising the following, A welding process which welds to a groove joint formed in a comparison part of a welding work by making it run said welding control head while driving this welding torch according to this.

The 1st procedure that crosses said weld line, installs two or more groove blocks, and fixes welding works in groove shape of said groove joint.

The 2nd procedure in which the 2nd automatic detection means detects a position of a groove block within said groove shape.

Based on a detection result of the said 1st and 2nd automatic detection means, a direction of movement of welding is run said welding control head, driving said welding torch, The 3rd procedure of performing division welding into a portion which a portion which has said groove block among said groove shape makes said welding torch jumping [portion] over this groove block, makes it avoiding, and does not have said groove block among said groove shape.

The 5th procedure that makes it run said welding control head after said end of division welding, driving said welding torch based on the 4th procedure that removes said groove block, and a detection result of after said groove block withdrawal and the 1st automatic detection means, and welds the whole region within said

groove shape.

[Claim 16]In the welding process according to claim 15, [said 2nd procedure] After moving this welding torch in the direction avoided so that said welding torch may not collide with said groove block, [by making it run said welding control head in this state where it avoided] A welding process being a procedure which detects automatically a position of a groove block within said groove shape by a detection means formed in this welding control head.

[Claim 17]A welding process welding to a rectilinear shape groove joint of an approximately plate-like welding work in the welding process according to claim 15.

[Claim 18]A welding process performing all position welding to a circumference shape groove joint of an approximate circle pipe-shaped welding work in the welding process according to claim 15.

[Detailed Description of the Invention]

[0001]

[Industrial Application]In the groove joint currently fixed by two or more groove blocks which crossed the weld line and were established, especially this invention provides suitable automatic welding equipment and welding process to weld welding works with respect to welding of a groove joint.

[0002]

[Description of the Prior Art]Generally, quality and reliable welding structure is searched for in welding of an important structure like a nuclear power generation plant or a chemical plant. And in order to secure the accuracy of dimension and welding quality of a groove joint, after conducting the presence inspection to a groove joint before welding and welding for example, quality inspection to the welding result is conducted. That is, in the presence inspection before welding, when it becomes a failure as the accuracy of dimension of a groove joint being insufficient, operation permission of welding should not be accepted, but construction of a groove joint should be again changed so that accuracy of dimension may be fulfilled. To a welding work which attends before welding and needs an inspection, the positioning fix of the welding work of a groove joint is carried out by two or more groove blocks which crossed and attached the weld line so that the shape and accuracy of dimension of the groove joint can be inspected.

[0003]As an example of the groove joint fixed with such a groove block, the circumference groove joint of a circle pipe is shown in drawing 22 (a) - (c). In drawing 22 (a), some (for example, four places) groove blocks 503 are established on the weld line of the direction of a circumference of the groove joint 502 formed among the welding works 501a and 501b of a setting circle pipe (pipe). The B-B section which is a non-installation place of the groove block 503 at drawing 22 (b) about the A-A section which is an installation place of this groove block 503 is shown in drawing 22 (c), respectively. As shown in drawing 22 (b), the welding works 501a and 501b on either side and the groove block 503 are being fixed by the welding 504.

[0004]The groove joint 512 which formed the insert ring 505 as shown, for example in drawing 23 may be used as a modification of the circumference groove joint of the setting circle pipe shown in drawing 22 (a).

[0005]As mentioned above, as the example was given and explained, also in the groove joint fixed with the groove block which crossed and attached the weld line, it may have to attend before welding and an inspection may have to be undergone. It will pass this presence inspection, will begin and operation permission of welding

will be approved.

[0006]Usually, the welding of a groove joint must perform multilayer multi-path welding, and advanced welding technique is needed from moreover the quality welding result of perfect penetration being required to the back side.

(1) Welding of manual operation was performed by the skillful welding operation company who has advanced welding skill conventionally as a welding process of the basis of the manual welding above-mentioned background, and the groove joint with a groove block mentioned above. The welding process at this time welds sending and carrying out melting of the filler metal (welding wire) into the arc which a TIG (tungsten inert gas) arc welding process is mainly used, for example, was generated between the electrode of the welding torch of a manual type, and the welding base material.

[0007]Root running of the part in which the groove block is not installed will be first performed in the form which carries out division welding (the number of rates becomes equal to the installation number of a groove block at this rate) intermittently from the groove block being installed in two or more places so that a weld line may be crossed especially at this time. It must be made for a uniform penetration bead to have to form at this time, carrying out melting thoroughly to the back side. After finishing intermittent division welding of the above-mentioned groove block sheep installation place, root running of the whole which removes a groove block and includes welding of the remaining non-welds currently divided is performed in the form connected to the bead by previous division welding. In this connection welding, in order to make a uniform penetration bead form, careful advanced construction art is required for the welding processing of superposition by the front bead and the bead under welding.

[0008]Thus, after ending root running, multilayer multi-path welding from a next layer for this groove joint to be filled up with molten metal to a final stratum is carried out further one by one. That is, a welding operation company does manual operation of the welding torch, and performs TIG welding. A welding bead is made to form in the welding operation at this time, at the same time it sends a filler metal into an arc, making a welding torch rock skillfully (weaving motion).

[0009]

[Problem to be solved by the invention]However, it is said from the former that manual welding operation is labor under adverse environment, and especially multilayer multi-path welding cannot but become the severe work covering a long time. And if it welds by the manual operation of the welding torch by a skillful welding operation company to the groove joint with which the groove block is installed so that a weld line may be crossed as mentioned above, The influence which the skill and condition of the worker who takes charge have on a welding result is great, and it is difficult to secure always healthy and good welding quality. It is expected with a skilled worker's aging or a welding successor's shortage that a skillful welding operation company's reservation will become difficult in the future. Therefore, it is required strongly that automation and advancement of welding should be attained.

[0010](2) General-purpose automatic welding equipment is developed and put in practical use in general-purpose automatic welding equipment, then the form according to the request to the above-mentioned automation. That is, the welding head provided with the welding torch is provided on a cart, and it welds because a worker operates these operations by remote control with a switch etc. In using such general-purpose automatic welding equipment, Root running including division welding under groove block installation and connection welding immediately after groove block removal and subsequent number path welding are performed by manual welding by the skillful welding operation company of the above (1), and only multilayer

multi-path welding after this will attach this automatic welding equipment, and will be performed. After setting automatic welding equipment to a predetermined position at the time of multilayer multi-path welding, the corrective action of a welding position or a welding condition is performed by manual operation, monitoring a welding condition continuously, and a skillful welding operation company carries out welding operation one by one, making a welding torch and a welding wire rock.

[0011](3) manual operation -- unnecessary automatic welding equipment -- in here, the manual operation by a welding operation company is still required in the general-purpose automatic welding equipment of the above (2). That is, since it does not have the automatic setting function and zero offset capability of a welding position and a welding condition during welding, a welding operation company monitors the welded situation continuously for every welding path, and has to perform correction of a welding position, setting out, change of a welding condition, etc. frequently by manual operation. Then, automation is advanced, the automatic welding equipment which makes unnecessary fundamentally surveillance and manual operation under welding is advocated, and there are the following as known art about this, for example.

** The known art of ******4-59993********* operation-determination-performs multilayer distribution welding of a union liner for amendment of a torch target position, or welding condition amendment based on the information on the groove detection obtained from a weld line and the optical distance sensor made to rock in the right-angled direction.

** The known art of ******3-75268********* picturizes the image of the weld containing arc light with a television camera, calculates a relative position from the luminance distribution, and performs correction control of a torch position.

** After it distributes the known art of ******2-54188********* in both the welding directions used as the Joshin posture and it teaches a weld line, it performs execution control of welding by reproduction of the teaching data.

[0012]In here, when it is going to apply the automatic welding equipment by above-mentioned known art ** - ** to the circumference groove joint of a setting circle pipe with a groove block, the following problems exist. That is, in the automatic welding equipment by known art **, the weld of arc light performs multilayer multi-path welding by **** welding (submerged arc welding) covered by flux. Since this **** welding uses that an electrode serves as a filler metal, and flux, it has a possibility that molten metal and flux may flow depending on a welding position, and becomes large-sized welding equipment easily. Therefore, it is difficult to apply to welding of the circumference groove joint of the setting circle pipe which installs the welding control head itself in the perimeter of a fixed pipe, and performs all position welding. In welding of the circumference groove joint of a setting circle pipe, arc welding (TIG welding, plasma welding, etc.) on which arc light is scattered is usually adopted, it is **, that arc light has a great adverse effect on the detection result of an optical distance sensor in this case, and detection becomes impossible as a matter of fact. Since the optical distance sensor is made to rock in a weld line and the right-angled direction here, the rocking mechanism is required, it is easy to become complicated, and groove sectional shape changes with the size of welding speed easily.

[0013]In the automatic welding equipment by known art **, while the arc has occurred, although the image pick-up by a television camera is possible, at the time of arc quenching, a picture disappears using the luminance distribution of the arc light. That is, in the case of the circumference groove joint of a setting circle pipe with a groove block, as mentioned above, supposing it performs division welding under groove block installation automatically, it is necessary to detect the position of a groove block in advance of division welding but, and the location detection in this case is impossible. On the contrary, supposing it adjusts luminance

distribution setting out by the side of a television camera so that this location detection may be possible, it will become shortly impossible to groove information detect at the time of welding. That is, obstacle location detection at the time of un-welding and groove information detection at the time of welding are enabled simultaneously, but no full automation of welding operation can be attained. In order to extract the luminance distribution of the infrared area of arc light, a special large-sized camera is needed.

[0014]In the automatic welding equipment of known art **, since it is made to weld by distributing to the Joshin attitude directions, the teach action of a weld line and the welding operation of reversal become complicated easily, and it cannot apply to welding of the circumference groove joint of the setting circle pipe which performs all position welding which goes around the circumference.

[0015]After all, in the automatic welding equipment of known art ** - **, since it does not have a welding operation control facility which jumps over the obstacle which crossed the weld line and was attached, it is inapplicable to automatic welding of a groove joint with a groove block. That is, as well as the general-purpose automatic welding equipment of the above (2) though it uses it, after removing after all the groove block which crossed the weld line and was attached, it is applicable only from backward [which carried out several layer number path implementation of the manual welding].

[0016][the 1st purpose of this invention] [by enabling automatic welding while jumping over an obstacle, and automatic welding after the obstacle removal using the detection means which both enables obstacle location detection at the time of un-welding, and groove information detection at the time of welding] It is providing the automatic welding equipment and the welding process which can attain full automation of the welding operation in the groove joint welding of the welding work which has a groove block on a weld line.

[0017]The detection means which both enables obstacle location detection at the time of un-welding and groove information detection at the time of welding is used for the 2nd purpose of this invention, By enabling all position automatic welding while jumping over an obstacle, and all position automatic welding after the obstacle removal, it is providing the automatic welding equipment and the welding process which can attain full automation of the welding operation in the circumference groove joint welding of the setting circle pipe which has a groove block on a weld line.

[0018]

[Means for solving problem]The welding torch of working which welds to the groove joint formed in the comparison part of a welding work according to this invention in order to attain the 1st purpose of the above, The welding control head of the self-propelled formula is provided with the torch driving means which drives this welding torch, meets the weld line of said groove joint mostly, and it runs to the direction of movement of welding, The guide rail to which it shows a run of said welding control head, and the 1st detection means that detects the welding position of said welding torch at the time of welding, Based on the detection result of this 1st detection means, the welding output conditions of said welding torch, In the automatic welding equipment which has a control means which controls the drive operation of said torch driving means, and run operation of said welding control head, and performs welding to said groove joint, Have further the 2nd detection means that detects the position, the shape, and the size of the obstacle formed the groove shape of said groove joint, and in this groove shape at the time of un-welding, and, [and said control means] So that said welding torch may weld the portion which does not have said obstacle among said groove shape based on the detection result of the said 1st and 2nd detection means, and the portion which has said obstacle among said groove shape may not weld but this obstacle may be jumped over and avoided, The welding output conditions of said welding torch, the drive operation of said torch driving means, And so that it may weld continuously over the

whole region within said groove shape, [based on the detection result of a jump welding control means to control run operation of said welding control head, and said 1st detection means] [said welding torch] Automatic welding equipment provided with the continuous-welding control means which controls the welding output conditions of said welding torch, the drive operation of said torch driving means, and run operation of said welding control head is provided.

[0019]In said automatic welding equipment, preferably, [the said 1st and 2nd detection means] Are the one same detection means and, [and this one detection means] A line floodlight which irradiates said groove joint with linear light, and a camera which picturizes a reflected figure of said linear light, Image Processing Division of the detection image of this camera is carried out, and automatic welding equipment provided with an image processing means which extracts required information about said groove shape, the position, shape and a size of said obstacle, and said welding position is provided.

[0020]In said automatic welding equipment, preferably, [said continuous-welding control means] The 1st course calculating means that calculates a welding path in case said welding torch welds inside of said groove shape over the whole region, Based on the result of an operation of this 1st course calculating means, welding output conditions of said welding torch, Drive operation of said torch driving means and run operation of said welding control head are controlled, and automatic welding equipment provided with the 1st welding execution means that performs continuous welding covering the whole region within said groove shape is provided.

[0021]In said automatic welding equipment, preferably, [said continuous-welding control means] Welding output conditions of said welding torch have further the 1st welding condition memory measure that a setting input is beforehand carried out as two or more kinds of welding data, and is memorized, and, [said 1st welding execution means] Automatic welding equipment performing continuous welding covering the whole region within said groove shape according to one of two or more kinds of welding output conditions memorized by said 1st welding condition memory measure is provided.

[0022]In said automatic welding equipment, among two or more kinds of welding data memorized by said 1st welding condition memory measure, preferably, [at least a part] Automatic welding equipment being data of tack-welding conditions which are the energy of a size which melts only a side front of said groove joint and does not melt the back side is provided.

[0023]In said automatic welding equipment, preferably, [said continuous-welding control means] A deviation of a running direction of said welding control head at the time of welding and the direction of a weld line of said groove joint is calculated by being based on a detection result of said 1st detection means, Have further the 1st compensation means that amends a welding path calculated by said 1st course calculating means according to this deviation, and, [said 1st welding execution means] Automatic welding equipment controlling welding output conditions of said welding torch, drive operation of said torch driving means, and run operation of said welding control head based on this amended welding path is provided.

[0024]In said automatic welding equipment, preferably, [said 1st detection means] Are the position preceded in the welding direction rather than said welding torch, and it is being fixed to said welding control head, and so that it may become a position higher than height of said obstacle, [said 1st compensation means] Automatic welding equipment performing delay **** amendment which amends a welding path calculated by said 1st course calculating means is provided taking into consideration delay distance of said welding torch which is late for said 1st detection means, and runs based on a deviation calculated based on said 1st detection result.

[0025]In said automatic welding equipment, preferably, [said jump welding control means] The 2nd course calculating means that calculates an evasion course for a welding path and this welding torch in case said

welding torch welds the portion which does not have said obstacle among said groove shape to jump over and avoid said obstacle, Based on the result of an operation of this 2nd course calculating means, the welding output conditions of said welding torch, the drive operation of said torch driving means, and run operation of said welding control head are controlled, and automatic welding equipment provided with the 2nd welding execution means that performs jump welding is provided.

[0026]In said automatic welding equipment, preferably, [said jump welding control means] The welding output conditions of said welding torch have further the 2nd welding condition memory measure that a setting input is beforehand carried out as two or more kinds of welding data, and is memorized, and, [said 2nd welding execution means] The automatic welding equipment performing welding in said welding path according to one of two or more kinds of welding output conditions memorized by said 2nd welding condition memory measure is provided.

[0027]In said automatic welding equipment, among two or more kinds of welding data memorized by said 2nd welding condition memory measure, preferably, [at least a part] The automatic welding equipment being data of the tack-welding conditions which are the energy of the size which melts only the side front of said groove joint and does not melt the back side is provided.

[0028]In said automatic welding equipment, preferably, [said jump welding control means] A deviation of a running direction of said welding control head at the time of welding and the direction of a weld line of said groove joint is calculated by being based on a detection result of said 1st detection means, Have further the 2nd compensation means that amends a welding path calculated by said 2nd course calculating means according to this deviation, and, [said 2nd welding execution means] Automatic welding equipment controlling welding output conditions of said welding torch, drive operation of said torch driving means, and run operation of said welding control head based on this amended welding path is provided.

[0029]In said automatic welding equipment, preferably, [said 1st detection means] Are the position preceded in the welding direction rather than said welding torch, and it is being fixed to said welding control head, and so that it may become a position higher than height of said obstacle, [said 2nd compensation means] Automatic welding equipment performing delay **** amendment which amends a welding path calculated by said 2nd course calculating means is provided taking into consideration delay distance of said welding torch which is late for said 1st detection means, and runs based on a deviation calculated based on said 1st detection result.

[0030]In said automatic welding equipment, welding automatic welding equipment is preferably provided to a rectilinear shape groove joint of a welding work of approximately flat shape.

[0031]Preferably, in order to attain the 1st and 2nd purposes of the above, in said automatic welding equipment, automatic welding equipment performing all position welding is provided to a circumference shape groove joint of an approximate circle pipe-shaped welding work.

[0032]In order to attain the 1st purpose of the above, according to this invention, the 1st automatic detection means detects a welding position of a welding torch of working with which a welding control head of a self-propelled formula was equipped, [by making it run said welding control head, while driving this welding torch according to this] In a welding process which welds to a groove joint formed in a comparison part of a welding work, The 1st procedure that crosses said weld line, installs two or more groove blocks, and fixes welding works in groove shape of said groove joint, The 2nd procedure in which the 2nd automatic detection means detects a position of a groove block within said groove shape, Based on a detection result of the said 1st and 2nd automatic detection means, a direction of movement of welding is run said welding control head, driving said welding torch, The 3rd procedure of performing division welding into a portion which a portion which has

said groove block among said groove shape makes said welding torch jumping [portion] over this groove block, makes it avoiding, and does not have said groove block among said groove shape, It is made to run said welding control head after said end of division welding, driving said welding torch based on a detection result of the 4th procedure that removes said groove block, and after said groove block withdrawal and the 1st automatic detection means, A welding process having the 5th procedure that welds the whole region within said groove shape is provided.

[0033]In said welding process, preferably, [said 2nd procedure] After moving this welding torch in the direction avoided so that said welding torch may not collide with said groove block, [by making it run said welding control head in this state where it avoided] The welding process being a procedure which detects automatically the position of the groove block within said groove shape by the detection means formed in this welding control head is provided.

[0034]In said welding process, the welding welding process is preferably provided to the rectilinear shape groove joint of the welding work of approximately flat plate shape.

[0035]Preferably, in order to attain the 1st and 2nd purposes of the above, in said welding process, the welding process performing all position welding is provided to the circumference shape groove joint of an approximate circle pipe-shaped welding work.

[0036]

[Function]In this invention constituted as mentioned above, when welding the groove joint which has a groove block on a weld line, before starting welding, it is the 2nd detection means beforehand and the position, the shape, and the size of the groove block as an obstacle established in the groove shape of a groove joint and this groove shape are detected. And it is made to run the welding control head of the self-propelled formula provided with the welding torch of working to the direction of movement of welding along the weld line of a groove joint via a guide rail, a welding torch is simultaneously moved to a prescribed position suitably by a torch driving means (weaving is also a deed), and **** and welding are started. The detection result concerning the groove shape and the obstacle from the 2nd detection means first at this time, [according to the detection result about the welding position of the welding torch from the 1st detection means] A welding torch torch driving means and a welding control head are controlled by the jump welding control means formed in the control means, and while a welding torch welds the portion which does not have a groove block among groove shape, a groove block portion does not weld, but it jumps over a groove block and is avoided. For example, suspend welding operation in this side in which the groove block is installed, and. It jumps without making a welding torch avoid in the direction which goes up from a welding face, and making it collide with a groove block, and descends to a welding face in the position which passed the groove block enough, welding is resumed again, and welding operation to this side of the following groove block is performed. When only the groove block installation number repeats such jump operation, division welding of the parts other than a groove block installation place can be carried out intermittently. Thus, after division welding is completed, since welding works are fixed by a division welded section, even if it removes a groove block, a groove joint part is held. Corresponding [and] to the detection result concerning the welding position of the welding torch from the 1st detection means after removing a groove block, A welding torch torch driving means and a welding control head are controlled by the continuous-welding control means provided in the control means, the usual welding operation is performed, and a welding torch can be continuously welded over the whole region within groove shape. That is, root running of the whole including connection welding with division weld and subsequent multilayer multi-path welding can be performed continuously, without removing a welding control head.

[0037]The line floodlight which irradiates a groove joint with linear light by one detection means by which the 1st and 2nd detection means are the same, [by having carried out Image Processing Division of the detection image of the camera which picturizes the reflected figure of linear light, and this camera, and having the image processing means which extracts the required information about groove shape, the position, the shape and the size of an obstacle, and a welding position] While realizing the 1st detection means that detects the welding position of a welding torch at the time of welding, and the 2nd detection means that detects the position, the shape, and the size of the obstacle formed the groove shape of a groove joint, and in this groove shape at the time of un-welding, it can serve as these by one means. The 1st course calculating means that calculates a welding path in case, as for a continuous-welding control means, a welding torch welds the inside of groove shape over the whole region, Based on the result of an operation of this 1st course calculating means, the welding output conditions of a welding torch, [by having controlled the drive operation of a torch driving means, and run operation of the welding control head, and having the 1st welding execution means that performs continuous welding covering the whole region within groove shape] Based on the detection result of the 1st detection means, a means by which a welding torch welds continuously over the whole region within groove shape is realizable. The continuous-welding control means has further the 1st welding condition memory measure that the setting input of the welding output conditions of a welding torch is beforehand carried out as two or more kinds of welding data, and is memorized.

[the 1st welding execution means] [by performing continuous welding covering the whole region within groove shape according to one of two or more kinds of welding output conditions memorized by the 1st welding condition memory measure] The variation of a certain amount of [not setting up a welding condition by manual operation each time, either] welding output can be used properly.

That is, when performing from connection welding to multilayer multi-path welding at the time of continuous welding, repetition welding can be performed one by one until it carries out all the ends of a path according to a welding condition group given in the 1st welding condition memory measure. [by being data of the tack-welding conditions which are the energy of the size which the welding data memorized by the 1st welding condition memory measure melts only the side front of a groove joint, and does not melt the back side] Even if it is a time of starting welding all over the districts after division welding, before shifting to the final weld of multilayer many paths, a tack welding can be performed further. The deviation of the running direction of a welding control head and the direction of the weld line of a groove joint of [at the time of welding] is calculated by a continuous-welding control means being based on the detection result of the 1st detection means, Have further the 1st compensation means that amends the welding path calculated by the 1st course calculating means according to this deviation and, [the 1st welding execution means] [by controlling the welding output conditions of a welding torch, the drive operation of a torch driving means, and run operation of a welding control head based on this amended welding path] Even if it originates in the installation error of a guide rail, etc. and the deviation of a welding control head running direction and a groove joint welding line direction occurs, this deviation can amend automatically the influence which it has on continuous welding. The 1st detection means is the position preceded in the welding direction rather than the welding torch, and it is being fixed to the welding control head so that it may become a position higher than the height of an obstacle. The 1st compensation means taking into consideration the delay distance of the welding torch which is late for the 1st detection means and runs based on the deviation calculated based on the 1st detection result. [the compensation means] By performing delay **** amendment which amends the welding path calculated by the 1st course calculating means, a means to amend the welding path calculated by the 1st course calculating

means is realizable according to the deviation of the running direction of a welding control head, and the direction of the weld line of a groove joint.

The 2nd course calculating means that calculates an evasion course for a welding path and a welding torch in case, as for a jump welding control means, a welding torch welds the portion which does not have an obstacle among groove shape to jump over and avoid an obstacle, [by having controlled the welding output conditions of a welding torch, the drive operation of a torch driving means, and run operation of the welding control head, and having the 2nd welding execution means that performs jump welding based on the result of an operation of this 2nd course calculating means,] The portion which does not have an obstacle among groove shape makes a welding torch weld based on the detection result of the 1st and 2nd detection means, and the portion with an obstacle does not weld but can realize a means to make an obstacle jump over and avoid. The jump welding control means has further the 2nd welding condition memory measure that the setting input of the welding output conditions of a welding torch is beforehand carried out as two or more kinds of welding data, and is memorized.

The 2nd welding execution means can use the variation of a certain amount of [not setting up a welding condition by manual operation each time, either] welding output properly by performing welding in a welding path according to one of two or more kinds of welding output conditions memorized by the 2nd welding condition memory measure.

[by being data of the tack-welding conditions which are the energy of the size which the welding data memorized by the 2nd welding condition memory measure melts only the side front of a groove joint, and does not melt the back side] The bottom of a groove joint can be fixed without interfering with the first layer Uranami welding in continuous welding performed behind. A jump welding control means calculates the deviation of the running direction of a welding control head and the direction of the weld line of a groove joint of [at the time of welding] by being based on the detection result of the 1st detection means, Have further the 2nd compensation means that amends the welding path calculated by the 2nd course calculating means according to this deviation, and, [the 2nd welding execution means] [by controlling the welding output conditions of a welding torch, the drive operation of a torch driving means, and run operation of a welding control head based on this amended welding path] Even if it originates in the installation error of a guide rail, etc. and the deviation of a welding control head running direction and a groove joint welding line direction occurs, the influence over which this deviation jumps and which it has on welding can be amended automatically. The 1st detection means is the position preceded in the welding direction rather than the welding torch, and it is being fixed to the welding control head so that it may become a position higher than the height of an obstacle.

The 2nd compensation means taking into consideration the delay distance of the welding torch which is late for the 1st detection means and runs based on the deviation calculated based on the 1st detection result. [the compensation means] By performing delay **** amendment which amends the welding path calculated by the 2nd course calculating means, a means to amend the welding path calculated by the 2nd course calculating means is realizable according to the deviation of the running direction of a welding control head, and the direction of the weld line of a groove joint.

Full automation of the welding operation in the straight line groove joint welding of the fixed plate which has a groove block on a weld line can be attained by welding to the rectilinear shape groove joint of the welding work of approximately flat plate shape.

[0038]Full automation of the welding operation in the circumference groove joint welding of the setting circle pipe which has a groove block on a weld line can be attained by performing all position welding to the

circumference shape groove joint of an approximate circle pipe-shaped welding work.

[0039]In this invention, before starting welding, it is the 1st procedure first, and in the groove shape of a groove joint, a weld line is crossed, two or more groove blocks are installed, and welding works are fixed. And the 1st automatic detection means detects the position of the groove block established in this groove shape in the 2nd procedure. In the 3rd procedure, driving the welding torch of working, based on the detection result of the 1st and 2nd automatic detection means, it is made to run the welding control head of a self-propelled formula to the direction of movement of welding, and welding is started. While a welding torch carries out division welding of the portion which does not have a groove block among groove shape based on the detection result of the 1st and 2nd automatic detection means at this time, a groove block portion does not weld, but jumps over and avoids a groove block. Namely, for example, suspend welding operation in this side in which the groove block is installed, and. It jumps without making a welding torch avoid in the direction which goes up from a welding face, and making it collide with a groove block, and descends to a welding face in the position which passed the groove block enough, welding is resumed again, and welding operation to this side of the following groove block is performed. When only the groove block installation number repeats such jump operation, division welding of the parts other than a groove block installation place is carried out intermittently, and welding works are fixed. Then, the 4th procedure removes a groove block, and it is made to run a welding control head, driving a welding torch in the 5th procedure based on the detection result of the 1st automatic detection means, and welds continuously over the whole region within groove shape. That is, root running of the whole including connection welding with division weld and subsequent multilayer multi-path welding can be performed continuously, without removing a welding control head.

[0040][by making it run a welding control head in this state where it avoided, after moving a welding torch in the direction avoided in the 2nd procedure so that a welding torch may not collide with a groove block] By detecting the position of the groove block within groove shape automatically by the detection means formed in the welding control head, a means to detect automatically smoothly the position of the groove block established in groove shape is realizable. Full automation of the welding operation in the straight line groove joint welding of the fixed plate which has a groove block on a weld line can be attained by welding to the rectilinear shape groove joint of the welding work of approximately flat plate shape. Full automation of the welding operation in the circumference groove joint welding of the setting circle pipe which has a groove block on a weld line can be attained by performing all position welding to the circumference shape groove joint of an approximate circle pipe-shaped welding work.

[0041]

[Working example]Hereafter, the embodiment of this invention is described with reference to Drawings. Drawing 1 - drawing 19 explain the 1st embodiment of this invention. Drawing 1 is a perspective view showing the outline composition of the automatic welding equipment by this example. The rail 10 which the automatic welding equipment 100 performs TIG arc welding, and was set as the welding work 1b of a setting circle pipe, It has the welding control head 9 which runs this rail 10 top, the welding controller 11 which performs the drive controlling of that welding control head 9, and the output control of the welding source 12, and the arithmetic and control unit 14 which performs operation management of this welding controller 11 and welding control head 9, and control. The operation pendant 13 for performing various input operations to this welding controller 11 is connected to the welding controller 11.

CRT16 and the keyboard 15 in which key operation is possible which perform a screen display are put side by side in the arithmetic and control unit 14.

[0042]This automatic welding equipment 100 welds the groove joint (circumference joint) 2 formed in a comparison part of the welding works 1a and 1b.

As four groove blocks 3 cross a weld line in the target groove joint 2, it is installed in it, and the insertion 5 is formed in a groove bottom (refer to drawing 9 mentioned later).

And by this insertion 5, in first layer Uranami welding of a final weld one-pass eye mentioned later, it is more uniform, and it is easy to form the rear bead 19b in a convex form, and it becomes it.

[0043]The wire 7 and the wire reel 8 which the welding control head 9 sends to the welding torch 6 and its torch tip are carried.

A direction as for which a direction which runs the rail 10 top moves a running shaft (Y-axis), the welding torch 6, and the wire 7 up and down A normal axis (Z-axis), A lateral axis (X-axis) and the direction of wire delivery are used as a feed shaft (W axis) for a direction which makes right and left rock the welding torch 6 and the wire 7, and the position transducer 92 (refer to drawing 2 mentioned later) which performs location detection of these each axis is built in.

[0044]The sensor head 21 for detecting information required for control of welding is formed in the position preceded toward the direction of movement of welding near the welding torch 6 and the wire 7.

It is being fixed to the welding control head 9 so that it may be the height which does not contact the groove block 3 which fixes the welding works 1a and 1b during welding operation and may become a position right above the groove joint 2.

Although the sensor head 21 can be gone up and down synchronizing with up-and-down motion of the welding torch 6 and the wire 7, it synchronizes with operation of right-and-left rocking.

[0045]The detection image from the sensor head 21 is taken into the sensor image processing device 22, and the sensor image processing device 22 distinguishes the groove shape and the welding position of the installation place of the groove block 3, and a part without the groove block 3, and detects required information. And this detection information is transmitted to the arithmetic and control unit 14 from the sensor image processing device 22.

[0046]The functional block diagram of welding control head 9, welding controller 11, arithmetic and control unit 14, and sensor image processing device 22 inside is shown in drawing 2. Each axial drive circuit 111 for the welding controller 11 to drive the welding control head 9 in drawing 2, Each shaft position count circuits 112 which receive the signal from the position transducer 92 in the welding control head 9, The welding output circuit 113 for making arbitrary current wave forms output to the welding torch 6 from the welding source 12, The control circuit 114 provided with the control software which controls the welding controller 11 whole, The input output circuit 115 which transmits the input signal from the operation pendant 13 to setting out, the store circuit 116, and the control circuit 114, The communication interface circuit 117 which transmits a command signal to the control circuit 114 from the arithmetic and control unit 14, The welding condition set up and changed from the arithmetic and control unit 14 or the operation pendant 13. (For example, the current Ip of a peak, the time Tp and the current Ib of a base, its time Tb, the welding speed V, the wire feed rate Wp, Wb, etc.) It comprises the welding indicator 118 which displays the current position of each axis (X, Y, Z) under operation operation on a control panel. The welding controller 11 takes in the command signal of remote control from the arithmetic and control unit 14, or the manipulate signal by the operation pendant 13, respectively, and has come to be able to perform the drive controlling of the welding control head 9, and the

output control of the welding source 12 by such composition.

[0047]As for the position transducer 92 in the welding control head 9, the pulse encoder is used for the X-axis of a right and left movement system of the welding torch 6, the Y-axis of the running system to a weld line direction, and the Z-axis of an up-and-down move system, respectively.

It can ask now for the current position of each axis by taking this pulse signal into the location detection count circuits 112 of the welding controller 11.

In order to make it the posture of the welding control head 9 especially known about the Y-axis of a traveling transfer system, the current position is denoted by the degree of attitude angle. About W axis currently used for wire delivery, it asks for a wire feed rate from the pulse signal of this detector.

[0048]The sensor image processing device 22 is provided with the laser floodlighting control source 22c which irradiates with a linear laser beam to the sensor head 21, the camera control console 22b which picturizes the reflected figure of the laser beam, and the image processing device 22a which processes the picturized picture.

Sensor detection operation is performed.

The picture monitor 23 for a monitor is connected to the image processing device 22a.

[0049]The personal computer (personal computer) is being used for the arithmetic and control unit 14.

The control program in the welding operation control section 142 starts via the man-machine interface circuit 144 by the key operation from the keyboard 15.

And the command signal transmitted from the welding operation control section 142 is transmitted to the control circuit 114 of the welding controller 11 via the communication interface circuit 141, and control of the welding control head 9 is performed by this command signal. The welding output data which sets the welding operation control section 142 working [welding operation], and is inputted via the communication interface circuit 141 from the welding control head 9, The position of the welding control head 9, the operation situation of the welding torch 6, and a welding condition are managed and controlled, taking in each present axial (X, Y, Z-axis) position data of a welding control head, and the processed data by which this position data was further processed by the position calculation treating part 147, respectively.

[0050]The communications parameter preparing part 146 which sets up communicative initialization and a parameter automatically at the time of operation so that the arithmetic and control unit 14 can perform communication with the arithmetic and control unit 14 and the welding controller 11, The display processing part 143 which processes various information, including a various data display and a data-processing display of the groove block 3 of an input screen and sensor detection, action indication at the time of automatic operation, etc., The path plan operation program creation part 149 created in quest of a path plan for every welding path required for multilayer multi-path welding of welding, i.e., a welding condition, by an automatic operation, It has the block jump arithmetic processing section 150 which calculates an evasion course of a welding path and a sheep installation place of an installation place of the groove block 3, and calculates operation of the welding control head 9 using information on the inputted groove block 3, and sensor detection information from the sensor image processing device 22. While a welding operation member looks at a screen displayed on CRT16, a basal condition for determining size shape and a welding condition of the groove joint 2 of the welding object works 1a and 1b is inputted into the path plan operation program creation part 149. Executive operation of the result of an operation in the block jump arithmetic processing section 150 is taken in and carried out to a welding operation control program in the welding operation control section 142.

[0051]The groove block detecting operation by the above-mentioned composition and subsequent welding

operation are explained below.

(1) The key map showing arrangement of the groove block 3 of a groove block which carries out detection detection is shown in drawing 3. As shown in drawing 3, height H and four groove blocks 3a-3d of the width W are installed by arbitrary angles (installation angle theta$_1$-theta$_4$) on the circumference of the groove joint 2.

The flow chart showing the order of the real way of operation which detects the groove block 3 arranged in this way is shown in drawing 4. As shown in drawing 4, as preparation before automatic operation, [the welding controller 11] While carrying out origin doubling operation required for the coordinate set of all the axes (X, Y, Z) in Procedure 161 by pendant operation, positioning operation instructions of the welding torch 6 will be issued, and it will be in the automatic operation waiting state which can be operated automatically in Procedure 163. The sensor image processing device 22 performs sensor detection coordinates doubling and setting out of operation in Procedure 185 so that the coordinates of the positioned welding torch 6 and the sensor head 21 may be in agreement, and it stands by as a detecting operation instruction waiting state in Procedure 186. And the arithmetic and control unit (personal computer) 14 is set as detection and jump operational mode of a block by keystroke of the keyboard 15 in Procedure 170. [and by pressing the execution key of block detecting operation operation in Procedure 171] Operation of this groove block detecting operation is started, and the welding controller 11 runs to each instructions taken out from the arithmetic and control unit (personal computer) 14 in the form where it is reported execution of that command operation as a result so that it may mention later.

[0052]That is, the arithmetic and control unit 14 takes out move demand instructions to a block detection start position with Procedure 172 first, and the welding controller 11 moves the welding control head 9 so that the sensor head 21 may come to a detection start position by Procedure 164 according to this, and it reports the result to the arithmetic and control unit 14. And the arithmetic and control unit 14 takes out Y-axis run demand instructions with Procedure 173, and the welding controller 11 which received this makes it run the welding control head 9 in Procedure 165. Run operation at this time is shown in drawing 5. Namely, as shown in drawing 5, in the welding control head 9, the welding torch 6 and the wire 7 are raised to height which does not contact each groove blocks 3a-3d, An arrow direction is run these, making the sensor head 21 precede in the welding direction rather than this welding torch 6 (precedence distance of the sensor head 21: Ls**50-100mm), and holding in a sufficiently high position. The running path Ys of the welding torch 6 at this time goes around the perimeter of the welding work 1a from a start position S point, and is to an end position E point. And the welding controller 11 will report that to the arithmetic and control unit 14, if such motion control is started.

[0053]The arithmetic and control unit 14 will take out picture taking-in demand instructions with Procedure 174 to the sensor image processing device 22, if a report is received. A picture taking-in operating command is taken out with Procedure 187 to the sensor head 21, the sensor image processing device 22 running according to this, as mentioned above. The laser floodlight 21a with which the sensor head 21 was equipped irradiates with linear light by this part which is going to detect the groove joint 2, and a reflected light of this linear light is picturized with the imaging camera 21b via the interference filter 21c which extracts only a laser beam and light of the wavelength. And the sensor image processing device 22 performs block detection and groove shape detection in Procedure 189, after performing processing image recognition in Procedure 188 to an image pick-up by this imaging camera 21b. Drawing 6 and drawing 7 explain a block and groove shape detection based on image recognition at this time.

[0054]A section of a part in which the groove block 3 in groove shape in the groove joint 2 is not installed, and

a part currently installed has become as shown in drawing 6 (1) and (2), respectively.

In drawing 6 (2), the groove block 3 is being welded and fixed by the welding works 1a and 1b via the welding holding part 4.

A raw picture which picturized a section shown in drawing 6 (1) among these, [drawing 7 (1)] And a detection image after capturing this raw image into the sensor image processing device 22 and performing Image Processing Division is shown in drawing 7 (2), A detection image after capturing drawing 7 (3) and this raw image into the sensor image processing device 22 for a raw picture which picturized a section shown in drawing 6 (2) and performing Image Processing Division is shown in drawing 7 (4). If the raw picture 24a of a groove line in the groove joint 2 is picturized like a graphic display and Image Processing Division of this is carried out all over the monitor display 24 in drawing 7 (1), It becomes the detection image 25a in which groove shape detection required for control of welding, such as the groove-shoulders width Ws as shown in drawing 7 (2), the groove center coordinates Qs, groove depth hs, the groove base width Wt, and the groove stepped surface product As, was performed. At this time, center-coordinates gap deltaQs of the groove center coordinates Qs based on non parallel of the rail 10 and a weld line originating in an attachment error of the rail 10, etc. is also displayed into a detection image. If Image Processing Division of the raw picture 24b of a block line in drawing 7 (3) is carried out, it will become the detection image 25b in which block detection required for operation of a groove block jump performed behind, such as check size L_c for checking that there is a block and block height H, was performed.

[0055]By detecting such a detection image continuously with a short time interval (every [for example,] second), and carrying out data processing of the detection result with the arithmetic and control unit 14, block installation situations, such as an installed position, height, the number, etc. of the groove block 3, can be judged. In this block detecting operation, are running above the welding torch 6 and the wire 7 to the weld line direction in the position which carried out rise evasion so that a weld line may be contacted and twisted to each groove block 3 currently crossed and installed, but. It is not restricted to this, but even if it carries out traveling transfer in the position which made the horizontal direction carry out move evasion of this welding torch 6 and wire 7, the contact to the groove block 3 is avoidable. Even in this case, block detecting operation can be performed by carrying out traveling transfer of the weld line and groove block 3 top for the sensor head 21 provided in the position of the height which precedes rather than the welding torch 6, and does not contact the groove block 3.

[0056]Between detection by the above-mentioned sensor image processing device 22, the arithmetic and control unit 14 takes out run location report demand instructions with Procedure 175 to the welding controller 11, and the welding controller 11 uses as present position data the operation result which the welding control head 9 mentioned above in Procedure 166, and reports it to the arithmetic and control unit 14. And the arithmetic and control unit 14 which received the report takes out detection result inquiry demand instructions with Procedure 176 to the sensor image processing device 22, The sensor image processing device 22 transmits to the arithmetic and control unit 14 by using as sensor detection data the detection result mentioned above in Procedure 190 according to this, in Procedure 191, serves as waiting for detecting operation instructions, and stands by. The arithmetic and control unit 14 performs processing of detection data and calculation of a block installed position in Procedure 177 from the transmitted detection result. And when it is not judged and filled with Procedure 178 whether the position Y of the welding torch 6 came to end position E, it returns to Procedure 174. That is, a series of sensor detection operations of Procedures 174-177 will

continue being repeated until the welding torch 6 as shown in drawing 5 goes around from start position S and reaches end position E.

[0057]After the conditions of Procedure 178 are fulfilled, namely, the welding torch 6 reaches end position E and the detecting operation by the sensor head 21 and the sensor image processing device 22 is completed, The arithmetic and control unit 14 with the welding controller 11 in Procedure 179, [Y-axis run deactivate-request instructions] Taking out reversal returning action demand instructions with Procedure 180, the operation according to these is made to perform on the welding control head 9 by Procedure 167a and b, the result is reported to the arithmetic and control unit 14, and in Procedure 168, the welding controller 11 will be in the state waiting for an operating command, and will stand by.

[0058]Then, the arithmetic and control unit 14 is Procedure 181, and calculates the evasion course for jump operation of the installation place of the groove block 3, and the welding path for the welding operation of a non-installation place from the detected sensor detection information. Drawing 8 and drawing 9 explain the technique of this path calculation. Drawing 8 is an explanatory view which jumps and expresses the motion paths of the welding torch at the time of welding, and drawing 9 is the detailed explanatory view. In drawing 8 and drawing 9, start position S (refer to drawing 5) in for example, the welding course started from welding start position S_o which is directly under a radial direction, A part [block / 3a (the block width W, installation angle $theta_1$) / first / 1st / groove] to be jumped by the groove block 3a is from a P_1 point to a P_4 point first. In order that the angle of this P_1 point and a P_4 point may avoid contact of the welding torch 6, it sets the outer diameter of L and the welding work 1a to D, and the contact evasion distance (the constant set up beforehand, for example, about 40 mm) established forward and backward is found from (1) type and (2) types, respectively.

$theta(P_1) = theta_1 - (360 - /pi - D) - (W/2 + L) \ldots\ldots (1)$

$theta(P_4) = theta_1 + (360 - /pi - D) - (W/2 + L) \ldots\ldots (2)$

If a groove depth is set to s and buffer distance is made into c_1, Z axial position Z_1 to which the welding torch 6 should go up and descend will be called for from (3) types.

$Z_1 = s + H + c_1 \ldots\ldots (3)$

On the other hand, a weld line of a part without a block will be from a welding start position S_o point to a P_1 point with from a P_4 point to a P_5 point. The angle theta of a P_5 point (P_5) is before the 2nd groove block 3b (installation angle $theta_2$).

(4) It asks from a formula.

$theta(P_5) = theta_2 - (360 - /pi - D) - (W/2 + L) \ldots\ldots (4)$

That is, welding path $S_o -> P_1$, $P_4 -> P_5$, and evasion course $P_1 -> P_2 -> P_3 -> P_4$ can be set up about the groove block 3a by these.

[0059]Also about other three groove blocks 3b, 3c, and 3d, with the same method as the above, theta (P_8), theta (P_9), theta (P_{12}), theta (P_{13}), Ask for theta (P_{16}) and, respectively Welding path $P_4 -> P_5$, $P_8 -> P_9$, and evasion course $P_5 -> P_6 -> P_7 -> P_8$, Welding path $P_8 -> P_9$, $P_{12} -> P_{13}$, and evasion course $P_9 -> P_{10} -> P_{11} -> P_{12}$ and

welding path P_{12}->P_{13}, P_{16}->E_0, and evasion course P_{13}->P_{14}->P_{15}->P_{16} can be set up. E_0 is welding end position here.

[0060]After setting calculation of a welding path and an evasion course is completed as mentioned above, it shifts to a procedure of block jump welding.

[0061](2) A flow chart which shows the order of the real way of block jump welding corresponding to shape of groove block 3 a-d by which block jump welding detection was carried out is shown in drawing 10 and drawing 11. As shown in drawing 10, as preparation of jump welding, first, the arithmetic and control unit 14 is Procedure 182, and calculates and draws up a welding path plan by the path plan operation program creation part 149 (refer to drawing 2). Drawing 12 explains details of this procedure 182. In drawing 12, it is chosen first whether a path plan is newly drawn up in Procedure 51 or a registered file is pulled out. When performing new creation, groove shape of the welding object works 1a and 1b is first inputted in Procedure 54, After carrying out the setting input of the basic welding condition required for welding construction in Procedure 55, it judges in Procedure 56 whether there is any error in this input, and if there is no error, Procedure 57 will perform automatic data processing of a welding path plan based on that input. So that it may write in a separate paragraph on right-hand side, [the main contents of processing in Procedure 57] Although Procedure 62 which calculates a groove cross-section area required to weld, and its determined groove cross-section area are buried. With Procedure 64 and welding which perform the procedure 63 of performing calculation of a number of layers of required welding, and a number of passes, pulsed current and calculation of time for every welding path, and calculation of a wire feed rate. . [making calculation and a welding torch of the procedure 65 of performing determination of bead height and calculation of total bead height which are laminated, and lamination bead width at that time rock] They are Procedure 66 which calculates required weaving conditions, the procedure 67 of performing calculation of a welding area and welding speed per layer, and Procedure 68 which calculates welding position coordinates for every welding path. after following the above procedures 57, data processing was carried out in Procedure 58 -- it is the result -- it indicates by a path plan.

[0062]On the other hand, when a drawer of an established file instead of new creation is chosen in Procedure 51, a number of an established file to pull out in Procedure 52 is inputted, and Procedure 53 draws out a file of the number. And the pulled-out contents (welding path plan) of a file are displayed in Procedure 69.

[0063]After displaying in Procedure 67 or Procedure 69, it shifts to Procedure 59 and it is chosen whether a file is edited or not. When not editing, it shifts to Procedure 61 promptly, but after a correction input for edit is performed by Procedure 60, it shifts to Procedure 61. It is chosen in Procedure 61 whether file registration is performed. When shifting to Procedure 195 which ends and mentions the procedure 182 whole later promptly when not registering, and registering, after Procedure 70 performs file registration, it shifts to Procedure 195. It cannot be overemphasized that it may be drawn up before a welding path plan shown in drawing 12 performs block detecting operation.

[0064]To a welding path plan drawn up in Procedure 182 as mentioned above, not only a welding condition used by groove block jump welding operation but a welding condition and welding coordinates for every welding path required for multilayer multi-path welding after block removal are indicated. Therefore, while this drawn-up welding path plan is read at the time of automatic operation by the welding operation control section 142 shown in drawing 2 and is used by groove block jump welding operation, [a plan] Also when performing continuously connection welding, root running, multilayer welding, etc. after removing operation of a groove block mentioned later, it will be used until the contents given in this welding path plan carry out all the ends of a

path.

[0065]After Procedure 182 is completed, the arithmetic and control unit 14 takes out sensor detection starting position move demand instructions with setting-out demand instructions of a welding condition, and Procedure 196, and takes out move demand instructions to a welding start position with Procedure 195 one by one in Procedure 197. According to this, the welding controller 11 sets up a welding condition (for example, if it is an one-pass eye conditions of a tack welding) based on a welding path plan calculated in previous Procedure 182 in Procedure 202, and reports the setting-out result, Take out instructions which move so that the sensor head 21 may serve as a sensor detection starting position (position shown in drawing 5) in Procedure 203 to the welding control head 9, and the move result is reported, Instructions which move so that the welding torch 6 may become welding start position S_o (drawing 8, nine references) from initial position P_o in Procedure 204 are taken out to the welding control head 9, and the move result is reported.

[0066]The arithmetic and control unit 14 which received the report takes out welding start demand instructions with Procedure 198, and according to this, [the welding controller 11] A run and welding of the welding control head 9 which goes to course S_o->E_o explained by drawing 8 and drawing 9 are made to start, and the ON signal of the purport that the welding start and the welding output operating command were outputted to the welding control head 9 in Procedure 205 is returned. The arithmetic and control unit 14 will take out picture taking-in demand instructions with Procedure 274 to the sensor image processing device 22, if an ON signal is received. The sensor image processing device 22 running in the course mentioned above according to this, it is Procedure 287 and a picture taking-in operating command is taken out to the sensor head 21 which precedes only precedence distance Ls rather than the welding torch 6. And the detection part of the groove joint 2 is irradiated with linear light with the laser floodlight 21a of the sensor head 21 like the time of block detection, That reflected light is picturized with the imaging camera 21b via the interference filter 21c, and after the sensor image processing device 22 performs processing image recognition in Procedure 288 to the image pick-up by this imaging camera 21b, Procedure 289 performs block detection and groove shape detection.

[0067]Between detection by the above-mentioned sensor image processing device 22, the arithmetic and control unit 14 takes out each axial location report demand instructions with Procedure 275 to the welding controller 11, and the welding controller 11 uses as present position data the operation result which the welding control head 9 mentioned above in Procedure 206, and reports it to the arithmetic and control unit 14. When it is not necessary to judge whether a torch position should be amended and Procedure 199 does not need to amend from the data of the torch position, [the arithmetic and control unit 14 which received the report] It shifts to Procedure 276 and detection result inquiry demand instructions are taken out to the sensor image processing device 22, and in Procedure 291, it transmits to the arithmetic and control unit 14 by using as sensor detection data the detection result mentioned above in Procedure 290 according to this, and the sensor image processing device 22 serves as waiting for detecting operation instructions, and stands by.

[0068]After Procedure 276, although Procedure 201 performs control calculation for detection data processing and the delay **** correction control of a torch position, this is later mentioned for the arithmetic and control unit 14.

[0069]It shifts to the procedure shown in drawing 11 after Procedure 201, and it is judged whether it arrived at the halt position (Y=P_1, P_5, P_9, P_{13}) of the part (four places) which has the groove block 3 in Procedure 221. When judged with having arrived at these positions, in Procedure 222 Welding and halt demand instructions of a run, Y-axis run demand instructions and location report demand instructions are taken out with Z-axis rise

demand instructions (P_1->P_2, P_5->P_6, P_9->P_{10}, P_{13}->P_{14}) for Procedure 223 to perform evasion of the welding torch 6, and a jump of the groove block 3, and Procedure 224. Since the welding controller 11 makes the operation corresponding to this perform on the welding control head 9, [the welding controller] Take out welding and run stop operation instructions with Procedure 211, and it reports to the arithmetic and control unit 14 by making the result into an OFF signal, Z-axis motion moving instructions are taken out with Procedure 212, the result is reported to the arithmetic and control unit 14, and after outputting a Y-axis run operating command in Procedure 213, Procedure 214 reports the present position data of the welding torch 6 to the arithmetic and control unit 14.

[0070]And the arithmetic and control unit 14 judges whether it is Procedure 225 with a receptacle one by one, and the welding torch 6 arrived the result report of the welding controller 11 to these operation execution at groove block 3 end position (Y=P_3, P_7, P_{11}, P_{15}). When judged with having arrived at these positions, Z-axis downward demand instructions (P_3->P_4, P_7->P_8, P_{11}->P_{12}, P_{15}->P_{16}) are taken out with Y-axis run deactivate-request instructions and Procedure 227, and welding start demand instructions are taken out with Procedure 226 in Procedure 228. Since the welding controller 11 makes the operation corresponding to this perform on the welding control head 9, [the welding controller] Take out Y-axis run stop operation instructions with Procedure 215, take out Z-axis motion moving instructions with Procedure 216, and the result is reported to the arithmetic and control unit 14, The welding start and welding output operating command for resuming welding of a part without the groove block 3 are taken out with Procedure 217, and it reports to the arithmetic and control unit 14 by making the result into an ON signal. Operation of a block jump of such a series is performed [number / of the groove blocks 3 / (4 times)]. That is, it returns to Procedure 274 mentioned above, and the same procedure is repeated until the welding torch 6 is judged to have reached welding-end-position E_o in Procedure 229. Each section to part S_o->P_1 without groove block 3 a-d in drawing 8, P_4->P_5, P_8->P_9, P_{12}->P_{13}, and P_{16}->E_o performs intermittent division welding by this, In each section to existing groove blocks [3a, 3b, 3c, and 3d] part P_1-P_4, P_5-P_8, P_9-P_{12}, and P_{13}-P_{16}, [by carrying out a welding halt by P_1 of each block this side, P_5, P_9, and P_{13}, and acting as a recurrence student of the arc in the position after a jump of P_4 of each block back, P_8, P_{12}, and P_{16}] The welding torch 6 is gone up, moved and dropped by a welding halt condition, and groove block 3 jump operation is performed. And the detecting operation by the sensor head 21 is interlocked with operation of the welding torch 6, and is performed.

[0071]In this jump welding operation, the tack-welding conditions of the small energy which is less than final weld are used, and as shown in drawing 13, it welds so that the welding bead 18 which did not melt to the back side but melted only the side front may form. Welding fixation of the bottom of a groove joint can be carried out without interfering with the first layer Uranami welding of final weld by welding in this way. Although not illustrated in particular, it is made to perform feedback control by detection of arc voltage during welding operation so that arc length may always become fixed.

[0072]The delay **** correction control to position gap deltaS (deltaX of an X axial direction and deltaZ of Z shaft orientations) of the welding torch 6 which originates in the installation error of the rail 10, etc. during the above-mentioned welding operation here is explained to details below.

[0073]As mentioned above, although only the number of the groove blocks 3 (4 times) is repeated between Procedure 247 - Procedure 229, [block jump welding operation] In the meantime, the sensor detection data

which the arithmetic and control unit 14 receives from the sensor image processing device 22 in Procedure 290 of drawing 10 turns into data detected in the position which always preceded only precedence distance Ls (precedence angle $theta_{Ls}$) rather than the movement zone ($theta_T$) of the welding torch 6. The angle ($theta_S$) of the sensor detection point at this time is shown by the following (5) types.

$$theta_S = theta_T + theta_{Ls} = theta_T + (360 \text{ and } Ls/pi\text{-}D) \ldots\ldots (5)$$

And the welding torch 6 at that time is performing welding operation in a position ($theta_T = theta_S - theta_{Ls}$) which was behind [a sensor detection point] only in angle $theta_{Ls}$.

[0074]Therefore, before a welding torch which is performing this welding operation reaches a sensor detection point ($theta_T = theta_S$), beforehand with Procedure 201, When calculation of delay **** correction control required for position gap amendment of the welding torch 6 is finished according to detection information on groove shape of a welding image shown in drawing 7 (2) and it is judged with the welding torch 6 needing to be amended in Procedure 199 using this detection data, That is, when the welding torch 6 reaches a sensor detection point, he takes out demand instructions to the welding controller 11 so that a torch position correction amount which shifted to Procedure 200 and had already been calculated may be set up, and is trying to make Procedure 207 perform amendment moving operation on the welding control head 9.

[0075]If it returns to drawing 11, welding advances and the welding torch 6 arrives at end position (Y=E_o), The arithmetic and control unit 14 judges with having arrived at welding end position in Procedure 229, and issues the Z-axis rise demand for carrying out welding operation terminating request instructions in Procedure 230, and carrying out evasion of the welding torch 6, and housekeeping operation of a next pass in Procedure 231, and Y-axis reversal returning action demand instructions. Since the welding controller 11 makes the operation corresponding to this perform on the welding control head 9, [the welding controller] After taking out the end operating command of welding with Procedure 218, reporting to the arithmetic and control unit 14 by making the result into welding and a run OFF signal, taking out Z-axis motion moving instructions and Y-axis reversal returning action instructions with Procedure 219 and reporting the result to the arithmetic and control unit 14, in Procedure 220, it will be in the state waiting for an operating command, and will stand by.

[0076]The arithmetic and control unit 14 which received the report shifts to Procedure 232, and while performing the end display of welding for telling a manipulating operator, a block removal demand display is performed. And it will shift to Procedure 233 and will be in the waiting state which waits to remove the groove block 3.

[0077]After block jump welding is completed as mentioned above, it shifts to the procedure of welding after block removal.

[0078](3) The flow chart showing the order of the real way of welding after the welding block removal after block removal is shown in drawing 14 and drawing 15. As shown in drawing 14, as for the arithmetic and control unit 14, a check of that the block was removed as preparation before welding in Procedure 244 will choose whether it is continuation of welding in Procedure 245. If continuation of welding is not chosen, end a flow promptly and all the work is completed, but. The inside of the welding condition group etc. which are indicated to the file of the welding path plan which renewal of a welding path was performed in Procedure 246, and was previously explained using drawing 12 when continuation of welding was chosen, The tack-welding (namely, connection welding which connects division welding formed intermittently) operation indicated to the two pass eye is started.

[0079]In this way, based on an updated welding path plan, first, the arithmetic and control unit 14 takes out setting-out demand instructions of a welding condition with Procedure 395, and takes out move demand instructions to a welding start position with Procedure 247 one by one. [the welding controller 11 which was in a state waiting for an operating command in previous Procedure 220 according to this] Set up a welding condition based on a welding path plan by which renewal computation was carried out in previous Procedure 246 in Procedure 302, and the setting-out result is reported to the arithmetic and control unit 14, Instructions which move so that the welding torch 6 may become welding start position S_o (it may differ from a welding start position in drawing 8, nine references, however jump welding) in Procedure 304 are taken out to the welding control head 9, and the move result is reported to the arithmetic and control unit 14.

[0080]The arithmetic and control unit 14 which received a report takes out welding start demand instructions with Procedure 398, and according to the, [the welding controller 11] A run and welding of the welding control head 9 which goes to course S_o->E_o (it jumps also over E_o and may differ from the time of welding) explained by drawing 8 and drawing 9 are made to start, and an ON signal of a purport that a welding start and a welding output operating command were outputted to the welding control head 9 in Procedure 305 is returned. The welding torch 6 at this time is performing welding operation in a position ($theta_T$=$theta_S$-$theta_{Ls}$) which was behind [a sensor detection point ($theta_S$)] only in precedence angle $theta_{Ls}$. The arithmetic and control unit 14 will take out picture taking-in demand instructions with Procedure 374 to the sensor image processing device 22, if an ON signal is received. The sensor image processing device 22 which was in a state waiting for a detecting operation instruction in previous Procedure 291 running in a course mentioned above according to this with Procedure 258, While taking out picture taking-in operation to the sensor head 21 and making a reflected light of the laser floodlight 21a of the sensor head 21 picturize with the imaging camera 21b, Image Processing Division recognition operation is performed to the image pick-up like the time of jump welding. Then, Procedure 259 detects a welding position gap by groove shape and the welding torch 6. A detection image after capturing into drawing 16 (1) an image pick-up student image detected in Procedure 259 at this time, capturing that raw image into the sensor image processing device 22 and performing Image Processing Division is shown in drawing 16 (2). If the raw picture 24a of a groove line (portion by which division welding has already been carried out) in the groove joint 2, the bead 18 of a tack welding, and the insertion 5 are picturized like a graphic display and Image Processing Division of this is carried out all over the monitor display 24 in drawing 16 (1), It becomes the detection image 27 in which groove shape detection required for control of welding, such as the groove-shoulders width Ws as shown in drawing 16 (2), the groove center coordinates Qs, groove depth hs, the groove base width Wt, and the groove stepped surface product As, was performed. At this time, center-coordinates gap deltaQs of the groove center coordinates Qs based on non parallel of the rail 10 and a weld line originating in an attachment error of the rail 10, etc. is also displayed into a detection image.

[0081]Between detection by the above-mentioned sensor image processing device 22, the arithmetic and control unit 14 takes out each axial location report demand instructions with Procedure 248 to the welding controller 11, and in it, [the welding controller 11] An operation result which the welding control head 9 mentioned above in Procedure 241 is used as present position data and welding output data, and is reported to the arithmetic and control unit 14. When it is not necessary to judge whether a torch position should be amended and Procedure 250 does not need to amend from data of the torch position probably, [the arithmetic

and control unit 14 which received a report] It judges whether it should shift to Procedure 252 and a welding condition should be amended from data of a welding condition, and when it is not necessary to amend, it shifts to Procedure 254. And detection result inquiry demand instructions are taken out with Procedure 254 to the sensor image processing device 22, and in Procedure 391, it transmits to the arithmetic and control unit 14 by using as sensor detection data a detection result mentioned above in Procedure 260 according to this, and the sensor image processing device 22 serves as waiting for detecting operation instructions, and stands by.

[0082]The arithmetic and control unit 14 in Procedure 255 like the time of jump welding after Procedure 254, [control calculation for detection data processing and delay **** correction control of a torch position] And control calculation for welding condition correction control is substituted for Procedure 256 before the welding torch 6 reaches a sensor detection point ($theta_T = theta_S$).

[0083]It returns to Procedure 347 and a series of such operations are repeated until the welding torch 6 is judged to have arrived at the welding end position ($Y = E_0$) 257 in Procedure 257. When it is judged at that time that Procedure 250 and Procedure 252 perform amendment of a torch position or a welding condition, [according to the calculation result for the amendment performed in previous Procedure 255 and Procedure 256] The welding condition correction amount setting-out demand instructions for carrying out disorder prevention of welding of the torch position correction amount setting-out demand instructions for losing position gap deltaS (delta X, delta Z) with Procedure 253 and adjustment of molten metal are taken out with Procedure 251 to the welding controller 11. According to this, torch position correction operation instructions are taken out with Procedure 242, it takes out welding condition correction operation instructions with Procedure 243, and he is trying for the welding controller 11 to make a welding control head carry out these correction operation. About the correction control of a welding condition, the groove joint 2 is mainly used among the above by the final weld (after-mentioned) which carries out multilayer multi-path welding. For example, correction control of changing welding current and weaving width to disorder prevention of welding, and changing welding speed and a wire feed rate to adjustment of molten metal is performed.

[0084]And if the welding torch 6 arrives at welding end position, the arithmetic and control unit 14 will judge with having arrived at welding end position in Procedure 257, and will shift to Procedure 230 shown in <u>drawing 15</u>. And the Z-axis rise demand for carrying out welding operation terminating request instructions in this procedure 330, and carrying out evasion of the welding torch 6 and housekeeping operation of a next pass in Procedure 331 and Y-axis reversal returning action demand instructions are issued. Since the welding controller 11 makes the operation corresponding to this perform on the welding control head 9, [the welding controller] After taking out the end operating command of welding with Procedure 318, reporting to the arithmetic and control unit 14 by making the result into welding and a run OFF signal, taking out Z-axis motion moving instructions and Y-axis reversal returning action instructions with Procedure 319 and reporting the result to the arithmetic and control unit 14, in Procedure 320, it will be in the state waiting for an operating command, and will stand by. It means that the tack welding was carried out as connection welding which connects division welding formed intermittently was able to be performed in the form of a tack welding and the perimeter in the groove joint 2 was shown by <u>drawing 13</u> by the above operation. Although not illustrated especially here, as an operator's judgment can perform change of a welding position, a welding halt, etc. from the keyboard 15 during welding operation, improvement in operativity and user-friendliness is aimed at.

[0085]Thus, after a tack welding (connection welding) of a two pass eye is completed, it is judged in Procedure 261 to be NO whether it is the end of the last pass, and it returns to Procedure 246.

[0086]And in Procedure 246, renewal of a welding path is performed again and welding of 3 path eye of a description, i.e., welding (first layer Uranami welding) operation of a final weld one-pass eye, is started by file of a welding path plan. Although welding is hereafter performed like the above-mentioned to Procedure 261, unlike a tack welding of division welding / connection welding to the above-mentioned, as shown in drawing 17, a welding condition which the rear bead 19 of perfect penetration forms is used as a welding condition at the time of this first layer Uranami welding. And after welding of a final weld one-pass eye finishes, it returns from Procedure 261 to Procedure 246 again, and is updated by welding operation of a final weld two pass eye. Thus, renewal of a welding path is performed and final weld which is multilayer multi-path welding is continued until the last pass is completed henceforth. An image pick-up student picture detected in Procedure 259 of the midst (after an end of three-layer 4 path) of this multilayer multi-path welding is shown in drawing 18. In drawing 18, I of the raw picture 26 of a groove line in the groove joint 2 and a bead of multilayer multi-path welding, RO, Ha, and NI are picturized like a graphic display all over the monitor display 24. If Image Processing Division of this is carried out, it will become being almost the same as that of a detection image shown in drawing 16 (2). And a repetition line crack, I as eventually shown in drawing 19 - Li's lamination multi-path bead are obtained one by one until it results in an end of the last pass (N=Np; the number of the last pass given in a path plan), and all the welding operation is ended in Procedure 264.

[0087]1st detection means by which the sensor head 21 and the sensor image processing device 22 detect a welding position in the above-mentioned composition at the time of welding, Both 2nd detection means that detects groove shape, and the position, the shape and the size of an obstacle at the time of un-welding is constituted, and the welding controller 11 and the arithmetic and control unit 14 constitute the control means which controls run operation of the drive operation and the welding control head of the welding output condition and torch driving means of a welding torch.

[0088]According to this example constituted as mentioned above, [by performing both groove block 3 detection before welding, and groove information detection at the time of welding with the sensor head 21 and the sensor image processing device 22] Since jump automatic welding (division welding) of the groove block 3 and automatic welding (connection welding and final weld) after groove block 3 removal can be performed continuously, full automation of the welding operation in groove joint 2 welding with the groove block 3 can be attained. Therefore, healthy welding quality can be acquired, aiming at the breakaway from the conventional manual welding. Since repetition welding can be performed one by one from connection welding to the end of multilayer multi-path welding according to the welding condition group of a description of a path plan, reduction of the make-ready times of welding can be aimed at. Since this deviation can amend automatically the influence which it has on welding even if it originates in the installation error of the rail 10, etc. and the deviation of welding control head 9 running direction and groove joint 2 weld line direction occurs, A series of jump welding - multilayer multi-path welding can be performed automatically, without using a nerve for the alignment of the welding torch 6 for every welding path, and a weld line, or correction of welding output conditions.

[0089]Although groove block 3 a-d was removed and connection welding by a tack welding was again performed after division connection by a tack welding in the 1st embodiment of the above, When the number of times of a tack welding is beforehand set once to a limitation at a welding path plan which it is not restricted to this but is updated in Procedure 246, There is no operation of a tack welding of this two pass eye, and it becomes what operation of first layer Uranami welding of a final weld one-pass eye is started for (that is, first layer Uranami welding serves as a role of connection welding). Although an embodiment which divides (1)

block detecting operation and (2) block jump welding operation, and performs them in the 1st embodiment of the above was shown, By doing calculation of block detection, a welding operation course, and a block evasion course in block jump welding operation shown in drawing 10 and drawing 11, block detecting operation shown in drawing 4 is also omissible. Thus, by the constituted order of the real way, it can repeat welding operation of a part without the groove block 3, and jump operation of a part with the groove block 3, and it not only can carry out correctly, but can lose a position gap of the welding torch 6 simultaneously. Although the insertion 5 was formed in the groove joint 2 in the 1st embodiment of the above, it is not restricted to this, but can apply also in welding of a groove joint which does not provide an insertion, and same effect is acquired. Although the automatic welding equipment 100 of the above-mentioned embodiment performed TIG arc welding, Even if it is a case where it is not restricted to this, for example, other welding processes, such as plasma arc welding and hot-wires TIG arc welding, are applied, by the same method as the above, it is possible to carry out block jump welding and welding after block removal, and same effect can be acquired also in these cases.

[0090]Drawing 20 and drawing 21 explain the 2nd embodiment of this invention. This example is an embodiment of the automatic welding equipment which welds to a monotonous welding work. The same numerals are given to a member equivalent to the 1st embodiment. Drawing 20 is a perspective view showing the outline composition of the automatic welding equipment 400 by this example. Main different points from drawing 1 in the 1st embodiment are that the welding works 1c and 1d are monotonous, and the rail 101 of the automatic welding equipment 400 becomes rectilinear shape in connection with this, and two groove blocks 103 are formed in the groove joint 102 of rectilinear shape. Other points are the same as the 1st embodiment almost.

[0091]Operation of the automatic welding equipment 400 of the above-mentioned composition is the same as that of the automatic welding equipment 100 of the 1st embodiment fundamentally, and same flows of control perform welding to the groove joint 102 through three procedures of welding after detection, (2) block jump welding, and (3) block removal of (1) groove block. Drawing 21 explains the calculation technique of a welding path for an evasion course for jump operation by the arithmetic and control unit 14 in Procedure 181 (refer to drawing 4) of detection of (1) groove block, and welding operation among these.

[0092]Drawing 21 is a figure equivalent to drawing 8 of the 1st embodiment, and is an explanatory view showing motion paths of a welding torch at the time of jump welding. In drawing 8, it is a welding course started from welding start position S_o, and a part [block / 103a (the block width W, installation distance Y_1 from S_o) / first / 1st / groove] to be jumped is from a P_1 point to a P_4 point. Distance from S_o of this P_1 point and a P_4 point sets to L contact evasion distance (a constant set up beforehand, for example, about 40 mm) established forward and backward in order to avoid contact of the welding torch 6, and it is found by (6) types and (7) formulas.

$$Y(P_1) = Y_1 - (W/2+L) \ldots\ldots (6)$$

$$Y(P_4) = Y_1 + (W/2+L) \ldots\ldots (7)$$

Similarly, the distance from S_o of a P_5 point and a P_8 point serves as (8) types and (9) types also about the 2nd groove block 103b (the block width W, installation distance Y_2 from S_o).

$$Y(P_5) = Y_2 - (W/2+L) \ldots\ldots (8)$$

$$Y(P_8) = Y_2 + (W/2+L) \ldots\ldots (9)$$

About distance Z_1 of a rise (P_1->P_2, P_5->P_6) of a welding torch or descent (P_3->P_4, P_7->P_8) in a block jump, it asks by (3) types explained in the 1st embodiment.

[0093]Namely, welding path S_o->$P_{1\text{concerning the groove block 103a by these}}$, P_4->P_5, and evasion course P_1->P_2->P_3->P_4, Welding path P_4->P_5 about the groove block 103b, P_8->E_o, and evasion course P_5->P_6->P_7->P_8 can be set up.

[0094]Procedures, such as the other control methods, are the same as that of the automatic welding equipment 100 of the 1st embodiment almost.

[0095]According to the automatic welding equipment 400 of this example, even if it is a case where it welds to the monotonous welding works 1c and 1d, the same effect as the 1st embodiment can be acquired.

[0096]

[Effect of the Invention]the groove [according to the automatic welding equipment of this invention] block detection at the time of un-welding, and the groove information detection at the time of welding -- the -- the [1 and] -- by carrying out by the detection means of two, Since automatic welding while jumping over an obstacle, and continuous automatic welding after the obstacle removal can be performed continuously, full automation of the welding operation in the groove joint welding which has a groove block on a weld line can be attained. Therefore, healthy welding quality can be acquired, aiming at the breakaway from the conventional manual welding.

[0097]Since repetition welding can be performed one by one until it carries out all the ends of a path according to a welding condition group given in the 1st welding condition memory measure when performing from connection welding to multilayer multi-path welding at the time of continuous welding, reduction of the make-ready times of welding can be aimed at. Since this deviation can amend automatically the influence which it has on continuous welding even if it originates in the installation error of a guide rail, etc. and the deviation of a welding control head running direction and a groove joint welding line direction occurs, A series of multilayer multi-path welding can be performed automatically, without using a nerve for the alignment of the welding torch for every welding path, and a weld line, or correction of welding output conditions. Since the influence over which this deviation jumps and which it has on welding can be automatically amended even if it originates in the installation error of a guide rail, etc. and the deviation of a welding control head running direction and a groove joint welding line direction occurs, Jump welding can be performed automatically, without using a nerve for the alignment of a welding torch and a weld line, or correction of welding output conditions. the groove [according to the welding process of this invention] block detection at the time of un-welding and the groove information detection at the time of welding -- the -- the [1 and] -- by carrying out by the automatic detection means of two, Since automatic welding while jumping over an obstacle, and continuous automatic welding after the obstacle removal can be performed continuously, full automation of the welding operation in the groove joint welding which has a groove block on a weld line can be attained. Therefore, healthy welding quality can be acquired, aiming at the breakaway from the conventional manual welding.

[Brief Description of the Drawings]
[Drawing 1]It is a perspective view showing the outline composition of the automatic welding equipment by the 1st embodiment of this invention.

[Drawing 2]It is a functional block diagram inside the welding control head shown in drawing 1, a welding controller, an arithmetic and control unit, and a sensor image processing device.

[Drawing 3]It is a key map showing arrangement of the groove block to detect.

[Drawing 4]It is a flow chart showing the order of the real way of operation which detects the groove block shown in drawing 3.

[Drawing 5]It is an explanatory view showing run operation of a welding control head.

[Drawing 6]It is a key map showing the section of the installation place and the non-installation place of a groove block.

[Drawing 7]It is a figure showing the detection image after performing Image Processing Division for the raw picture which picturized the section expressed to drawing 6, and this raw picture with a sensor image processing device.

[Drawing 8]It is an explanatory view showing the motion paths of the welding torch at the time of jump welding.

[Drawing 9]It is a detailed explanatory view of the motion paths of drawing 8.

[Drawing 10]It is a flow chart which shows the order of the real way of block jump welding.

[Drawing 11]It is a flow chart which shows the order of the real way of block jump welding.

[Drawing 12]It is a flow chart which shows the details of Procedure 182 shown in drawing 10.

[Drawing 13]It is a key map showing the tack-welding section carried out to a groove block non-installation place at the time of jump welding.

[Drawing 14]It is a flow chart showing the order of the real way of welding after block removal.

[Drawing 15]It is a flow chart showing the order of the real way of welding after block removal.

[Drawing 16]It is a figure showing the detection image after performing Image Processing Division for the raw picture which picturized the groove block non-installation place section already division welded, and this raw picture with a sensor image processing device.

[Drawing 17]It is a key map showing the welding section which is performed at the time of first layer Uranami welding and which completeness and a ****** rear bead produce.

[Drawing 18]It is a figure showing the raw picture which picturized the welding section of the multilayer multi-path welding midst.

[Drawing 19]It is a key map showing the welding section which the last pass ended and the lamination multi-path bead produced.

[Drawing 20]It is a perspective view showing the outline composition of the automatic welding equipment by the 2nd embodiment of this invention.

[Drawing 21]It is an explanatory view showing the motion paths of the welding torch at the time of jump welding.

[Drawing 22]It is a figure showing the structure of the circumference groove joint of a circle pipe.

[Drawing 23]It is a figure showing the structure of the groove joint in the case of providing an insert ring.

[Explanations of letters or numerals]

1a and 1b Welding work of a circle pipe

1c, a welding work monotonous 1 d

2 Groove joint

3a, 3b, 3c, and 3d Groove block

4 Welding holding part

5 Insertion

6 Welding torch

7 Wire

8 Wire reel

9 Welding control head

10 Rail

11 Welding controller

12 The welding source

13 Operation pendant

14 Arithmetic and control unit

15 Keyboard

16 CRT

18 Welding bead of tack welding

19 Rear bead of perfect penetration

21 Sensor head

21a A laser floodlight

21b An imaging camera

21c An interference filter

22 Sensor image processing device

23 Picture monitor

24 Monitor display

24a A raw picture of a groove line

24b A raw picture of a block line

25a and 25b A detection image after Image Processing Division

26 Raw picture of groove line at time of multi-path welding

27 Detection image after Image Processing Division

101 Straight line rail

102 Groove joint

103a and 103b A groove block

D An outer diameter of a welding work

E End position

E_o welding end position

H Groove block height

L Contact evasion distance

Ls Precedence distance of a sensor

Motion paths of a P_o - P_{16} welding torch

S Start position

S_o welding start position

W Groove block width

Y_1 and Y_2 groove block installed position

The angle of a theta$_S$ sensor detection point

theta$_T$ welding torch movement point

theta$_1$ - theta$_4$ groove block installation angle

I - Li Lamination multi-path bead

[Drawing 1]

1a,1b：円管の溶接ワーク	11：溶接コントローラ
2：開先継手	12：溶接電源
3a,3b：開先ブロック	13：操作ペンダント
6：溶接トーチ	14：演算制御装置
7：ワイヤ	15：キーボード
8：ワイヤリール	16：CRT
9：溶接制御ヘッド	21：センサヘッド
10：レール	22：センサ画像処理装置

[Drawing 2]

21 センサヘッド
ワイヤ 7 溶接トーチ 6
位置検出器 X,Y,Z,W 92
9

111 各軸駆動回路 (X,Y,Z,W) 各種位置カウント回路 112
溶接電源 12
溶接表示部
制御回路 溶接出力回路 113
操作ペンダント 13
118 入出力回路 表示部
入力教示部
116 設定・記憶回路 原点合わせ
溶接モード
通信インターフェース回路 左・右 走行前後
117 115 上・下 ワイヤ送り

141 通信インターフェース回路
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142 溶接動作制御部 位置計算処理部 147
143 画面表示処理部 150 ブロック及び演算処理部 パスプラン演算プログラム作成部 149
144 マンマシーンインターフェース回路
15 キーボード CRT 16 14

画像処理装置
22a カメラ制御器
22b レーザ投光制御電源
22c 22
直像モニタ 23

[Drawing 3]

θ4 3d C H θ1
3d W
1a 3a
3c
θ3 3b θ2
3b

3a,3b,3c,3d:開先ブロック
H:開先ブロック高さ
W:開先ブロック幅

[Drawing 5]

21a：レーザ投光器
21b：撮像カメラ
21c：干渉フィルタ
 E：エンド位置
 Ls：センサの先行距離
 S：スタート位置

[Drawing 6]
(1)

(2)

4：溶接固定部
5：インサート

[Drawing 7]

(1)

24a：開先線の生画像

(3)

24b：ブロック線の生画像

(2)

（開先形状検出）

25a：画像処理後の検出画像

(4)

（ブロック検出）

25b：画像処理後の検出画像

[Drawing 8]

D：溶接ワークの外径
E₀：溶接終了位置
P₀〜P₁₆：溶接トーチの動作経路
S₀：溶接開始位置

[Drawing 9]

L：接触回避距離

[Drawing 13]

1 8 :仮付け溶接の溶接ビード

[Drawing 18]

2 5 :多パス溶接時の開先線の生画像

[Drawing 4]

<溶接コントローラ>　　　　　　　<演算制御装置>　　　　　<センサ画像処理装置>
　　　　　　　　　　　　　　　　　（パソコン）

```
             ペンダント
             操作
  151  ┌──────────┐        ┌────────┐        ┌────────┐
       │ 原点合せ動作 │        │ キー入力 │        │ キー入力 │
       ├──────────┤        └────┬───┘        └────┬───┘
       │ 溶接トーチ   │             │                 │
       │ 位置決め動作指令│        ┌──────────┐         │
       └──────────┘        │ ブロックの検出及び│170      │
                           │ 飛び越し動作モード設定│     ┌──────────────┐
  163                      └──────┬───┘         │ センサ検出座標合せ │
    ○ 自動運転待機             ┌──────────┐      │ 及び動作設定     │185
                         171│ ブロック検出   │      └──────┬───────┘
                            │ 動作運転開始  │実行キー       │
                            └──────┬───┘             │
  164  ┌──────────┐        ┌──────────┐172         │
       │ 検出開始位置  │        │ ブロック検出開始 │           │
       │ 移動動作指令  │        │ 位置移動動作要求指令│     ┌──────────┐
       └──────────┘  結果     │ Y=S X=X₁ Z=Z₁│      186│ 検出動作指令待ち │
                       報告   └──────┬───┘          └──────────┘
                            ┌──────────┐173
                            │ Y軸走行要求指令│
                            │ Y=S→E       │
  165  ┌──────────┐        └──────┬───┘
       │ 走査動作指令  │  結果                       
       └──────────┘  報告   ┌──────────┐174  ┌──────────┐187
                            │ 画像取り込み要求指令├───│ 画像取り込み動作指令│
                            └──────┬───┘     └──────┬───┘
                            ┌──────────┐175  ┌──────────┐188
                            │ 走行現在位置報告 ├───│ 画像認識処理動作 │
  166  ┌──────────┐        │ 要求指令     │     └──────┬───┘
       │ 現在位置データ出力├──│          │     ┌──────────┐189
       └──────────┘        └──────┬───┘     │ ブロック検出及び │
                            ┌──────────┐176  │ 開先形状検出   │
                            │ 検出結果照合せ ├───└──────┬───┘
                            │ 要求指令     │     ┌──────────┐
                            └──────┬───┘     │ センサ検出データ出力│190
                            ┌──────────┐177  └──────┬───┘
                            │ 検出データ処理及び│     ┌──────────┐
                            │ ブロック設置位置計算│     │ 検出動作指令待ち │191
                            └──────┬───┘     └──────┬───┘
                            ╱◇────◇╲178          ○
                           ╱ 溶接トーチが  ╲N        ( C )
                           ╲ 終了位置Y=Eか?╱──┐
                            ╲◇────◇╱     │
  167a ┌──────────┐        ┌──────────┐179 │
       │ Y軸走行停止指令├──│ Y軸走行停止要求指令│◄─┘
       └──────────┘        └──────┬───┘
  167b ┌──────────┐        ┌──────────┐180
       │ Y軸反軸戻り動作指令├─│ Y軸反戻り動作要求指令│
       └──────────┘  結果報告└──────┬───┘
  168                       ┌──────────┐181
    ○ 動作指令待ち            │ 溶接動作軌跡及び │
    ( B )                    │ ブロック回避経路の計算│
                            └──────┬───┘
                                 ( A )
```
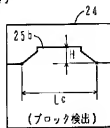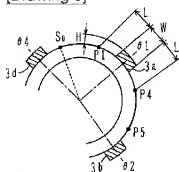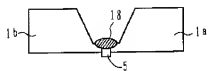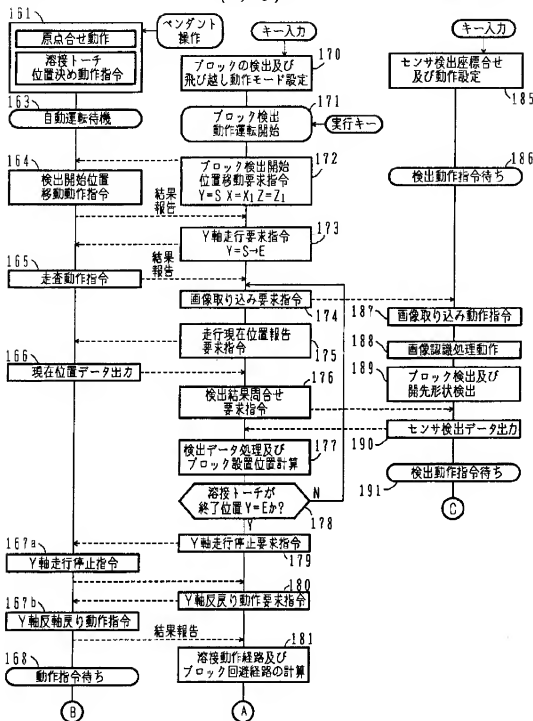
[Drawing 17]

1b ─ 　　　　　　　　　　　─ 1a

　　　　19

19：完全溶け込みの裏ビード

[Drawing 23]

```
      512
501b ──┐        ┌── 501a
       └──▢──┘
      505
```

[Drawing 10]

Ⓑ　　　　Ⓐ　　　　　　Ⓒ

182
溶接パスプラン演算

195
溶接条件設定要求指令

202
溶接条件設定　　設定結果

196
センサ検出開始位置
移動要求指令

203
移動動作指令　　移動結果

197
溶接開始位置移動要求指令
（Y＝S₀ X＝X₀ Z＝Z₀）

204
移動動作指令

198
溶接開始要求指令

205
溶接開始及び
溶接出力動作指令　　溶接及び
走行ON信号

274
画像取り込み要求指令

287
画像取り込み
動作指令

275
各軸現在位置報告要求指令

288
画像認識処理動作

206
現在位置データ出力

200
トーチ位置補正
量設定要求　　Y

199
トーチ
位置の補正
する？

289
ブロック検出及び
開先形状検出

207
X軸補正移動
動作指令

276
検出結果問合せ要求指令　　N

290
センサ検出データ
出力

201
検出データ処理及び
トーチ位置の遅延
倣い補正制御計算

291
検出動作
指令待ち

Ⓑ₁　　　Ⓐ₁　　　Ⓐ₂

[Drawing 11]

B1　　　　　　　　A1　　　　　　A2

221 — 一時停止位置か？
（Y＝P1,P5,P9,P13）　　N

Y

211 — 溶接及び走行停止動作指令

222 — 溶接及び走行の一時停止要求指令

OFF信号

212 — Z軸上昇動作指令

223 — Z軸上昇要求指令（P1→P2,
P5→P6,P9→P10,
P13→P14）

結果報告

213 — Y軸走行動作指令

224 — Y軸走行要求及び現在位置
判断要求指令（ブロック飛び）

214 — 現在位置データ出力

225 — ブロック飛び終了位置か？
（Y＝P3,P7,P11,P15）　　N

215 — Y軸走行停止動作指令

226 — Y軸走行停止要求指令

215 — Z軸下降動作指令

227 — Z軸下降要求指令（P3→P4,
P7→P8,P11→P12,
P15→P16）

結果報告

217 — 溶接開始及び溶接出力動作指令

228 — 溶接再開始要求指令

溶接及び走行
ON信号

229 — 溶接終了位置か？（Y＝E₀）　　N

218 — 溶接終了動作指令

230 — 溶接動作終了要求指令

溶接及び走行OFF信号

219 — Z軸上昇動作及び
Y軸反転戻り動作指令

231 — Z軸上昇要求及び
Y軸反転戻り動作要求指令

結果報告

220 — 動作指令待ち

232 — 溶接終了表示及び
ブロック除去要求表示

233 — ブロック除去待ち

[Drawing 16]

(1)

〈生画像〉

(2)

（開先形状検出）
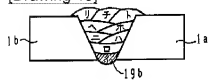
27：画像処理後の検出画像

[Drawing 19]

イ〜リ：階層多パスビード

[Drawing 12]

182

Ⓐ

51
新規
作成するか？ —Y

N

52
ファイル引出し
番号入力

53
ファイル引出し

54
開先形状設定入力

55
基本溶接条件
設定入力

56
入力OK？ —N

Y

57
溶接パスプランの
自動演算処理

69
引出ファイルの
表示

パスプランの表示

58
59
編集するか？ —N

Y

60
編集修正入力

61
登録するか？ —N

Y

70
ファイル登録

195へ

57

56より

62
開先断面積の計算

63
溶接の層数と
パス数の計算

64
溶接パス毎のパルス
電流とその時間の計算
及びワイヤ送り速度の
計算

65
積層ビード高さの決定
及び累計ビード
高さの計算

66
積層ビード幅の計算
及びウィービング
条件の計算

67
層当りの溶着面積及び
溶接速度の計算

68
溶接位置座標の計算

58へ

[Drawing 14]

〈溶接コントローラ〉 〈演算制御装置〉 〈センサ画像処理装置〉
                  （パソコン）

動作指令待ち
220

244 ─ ブロック除去確認

245 ─ 溶接継続か？ ── N ── 終了
              Y

246 ─ 溶接パス更新

395
302 ── 溶接条件設定要求指令
溶接条件設定

304   247
移動動作指令 ── 溶接開始位置移動要求指令
              (Y＝S₀,X＝X₀,Z＝Z₀)
         結果

305   398
溶接開始及び ── 溶接開始要求指令
溶接出力動作指令   溶接及び走行
              ON信号

374 ─ 画像取り込み要求指令

検出動作指令待ち
291

258 ─ 画像取り込み動作指令
       及び画像認識処理動作

各軸現在位置報告要求指令
241   248
現在位置データ及び
溶接出力データ出力   259 ─ 開先形状及び溶接
              位置ずれの検出

251   250
トーチ位置補正 ── Y ── トーチ位置の
量設定要求指令   補正するか？
242
トーチ位置補正動作指令   N

253   252
溶接条件補正量 ── Y ── 溶接条件の
設定要求指令   補正するか？
243
溶接条件補正動作指令   N

254 ─ 検出結果問合せ要求指令
              260 ─ センサ検出データ出力

255 ─ 検出データ処理及び
      トーチ位置の遅延伴い
      補正制御の計算

256 ─ 溶接条件補正制御計算

257 ─ 溶接終了位置か？
      Y＝E₀

B   A   A1

[Drawing 15]

B   A   Ａ₁

330
溶接動作終了要求指令

318
溶接終了動作指令

溶接及びOFF信号

331
Z軸上昇要求及び
Y軸反転戻り動作
要求指令

319
Z軸上昇動作及び
Y軸反転戻り動作指令

結果報告

320
動作指令待ち

261
最終パス終了か？
N＝Np   N

Y

264
全溶接作業終了

[Drawing 20]

400

9
8
21
102
103
6
7
101
103
1d
1c

101：直線レール
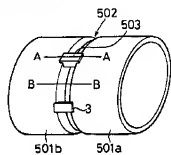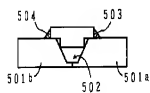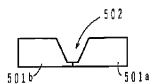102：開先継手
103a,103b：開先ブロック
1c,1d：平板の溶接ワーク

[Drawing 21]

Y_1, Y_2：開先ブロック設置位置

[Drawing 22]

(a)

(b)

(c)

[Translation done.]